SEQUENCE LISTING

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<120> Gene cluster involved in nogalamycin biosynthesis, and its use in production of antibiotics

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acgatgcgtt cgccttcccg ttctccaccg ccggcaccgc cctgacggcg tgggtcgcgc 15900

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<210> 2
<211> 342
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *snog*I, function: aminotransferase"

<400> 2

Met Thr Val His Val Trp Asp Tyr Leu Pro Glu Tyr Glu Leu Glu Arg
1 5 10 15

Glu Asp Ile His Asp Ala Val Glu Thr Val Phe Arg Ser Gly Arg Leu
20 25 30

Val Leu Gly Glu Ser Val Arg Gly Phe Glu Ser Glu Phe Ala Ser Phe
35 40 45

Gln Gly Val Gly His Ala Val Gly Val Asp Asn Gly Thr Asn Ala Val
50 55 60

Lys Leu Gly Leu Gln Ala Leu Gly Val Gly Pro Gly Asp Glu Val Val
65 70 75 80

Thr Val Ser Asn Thr Ala Ala Pro Thr Val Val Ala Ile Asp Ser Ala
85 90 95

Gly Ala Thr Pro Val Phe Val Asp Val Arg Glu Glu Asp Tyr Leu Met
100 105 110

Asp Thr Ser Gln Val Glu Ala Val Leu Thr Pro Arg Thr Arg Cys Leu
115 120 125

Leu Pro Val His Leu Tyr Gly Gln Cys Val Asp Met Ala Pro Leu Arg
130 135 140

Asp Leu Ala Ala Arg His Asn Leu Val Ile Leu Glu Asp Cys Ala Gln
145 150 155 160

Ala His Gly Ala Arg Arg His Gly Arg Leu Ala Gly Ser Thr Gly Asp
165 170 175

Ala Ala Ala Phe Ser Phe Tyr Pro Thr Lys Val Leu Gly Ala Tyr Gly
180 185 190

Asp Gly Gly Ala Val Leu Thr Asp Asp Glu Arg Val Ala Asp Arg Leu
195 200 205

Arg Arg Leu Arg Tyr Tyr Gly Met Glu Ser Arg Tyr Tyr Val Val Glu
210 215 220

Thr Pro Gly His Asn Ser Arg Leu Asp Glu Val Gln Ala Glu Ile Leu
225 230 235 240

Arg Arg Lys Leu Ser Arg Leu Pro Ser Tyr Ile Glu Ala Arg Arg Ala
245 250 255

Val Ala Arg Arg Tyr Glu Glu Gly Leu Ala Asp Thr Gly Leu Leu Leu
260 265 270

Pro Arg Thr Ala Gln Gly Asn Glu His Val Tyr Tyr Val Tyr Val Val
275 280 285

Arg His Pro Arg Arg Asp Ala Val Leu Glu Ala Leu Arg Ala Ser Tyr
290 295 300

Asp Ile Ala Leu Asn Ile Ser Tyr Pro Trp Pro Val His Thr Met Thr
305 310 315 320

Gly Phe Ser His Leu Gly Tyr Ala Lys Gly Ser Leu Pro Val Thr Glu
325 330 335

Ala Leu Ala Asp Glu Ile
340

<210> 3
<211> 293
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *snogJ*, function: dTDP-glucose synthase"

<400> 3

Val Lys Gly Ile Ile Leu Ala Gly Gly Thr Gly Ser Arg Leu His Pro
1 5 10 15

Thr Thr Leu Ala Val Ser Lys Gln Leu Leu Pro Val Gly Asp Lys Pro
20 25 30

Met Ile Tyr Tyr Pro Leu Ser Val Leu Met Leu Ala Gly Val Thr Asp
35 40 45

Ile Leu Ile Ile Ser Thr Pro His Glu Leu Pro Arg Met Arg Arg Leu
50 55 60

Phe Gly Asp Gly Ala Gln Leu Gly Leu Arg Leu Ala Tyr Ala Glu Gln
65 70 75 80

Glu Lys Pro Arg Gly Ile Ala Glu Ala Phe Leu Ile Gly Ala Asp His
85 90 95

Val Gly Ser Asp Ala Val Ala Leu Ala Leu Gly Asp Asn Ile Phe His
100 105 110

Gly Ser Ser Phe Gln Gly Val Leu Arg Lys Glu Ala Glu Glu Leu Asp
115 120 125

Gly Cys Val Leu Phe Gly Tyr Pro Val Lys Asp Pro Gln Arg Tyr Gly
130 135 140

Val Gly Glu Ala Asn Ala Ser Gly Arg Leu Val Ser Ile Glu Glu Lys
145 150 155 160

Pro Val Arg Pro Arg Ser Asn Arg Ala Ile Thr Gly Leu Tyr Phe Tyr
165 170 175

Asp Asn Glu Val Val Asp Ile Ala Arg Arg Leu Arg Pro Ser Ala Arg
180 185 190

Gly Glu Leu Glu Ile Thr Asp Ile Asn Arg Thr Tyr Met Glu Arg Gly
195 200 205

Arg Ala Arg Leu Val Asp Leu Gly Arg Gly Phe Ala Trp Leu Asp Thr
210 215 220

Gly Thr Pro Glu Ser Leu Leu Gln Ala Ser Gln Tyr Val Ser Ala Leu
225 230 235 240

Glu Glu Arg Gln Gly Ile Arg Ile Ala Cys Ile Glu Glu Val Ala Leu
245 250 255

Arg Met Gly Phe Ile Asn Ala Gln Ala Cys Tyr Glu Leu Gly Ala Arg
260 265 270

Leu Ser Gly Ser Gly Tyr Gly Gln Tyr Val Met Ala Ile Ala Glu Glu
275 280 285

Cys Thr Gly Arg Val
290

<210> 4
<211> 238
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *snog*A, function: aminomethyl transferase"

<400> 4

Val Tyr Gly Arg Glu Leu Ala Asp Val Tyr Glu Met Val Tyr Arg Ser
1 5 10 15

Arg Gly Lys Ser Trp Ala Asp Glu Ala Glu Arg Val Thr Ala Glu Ile
20 25 30

Arg Ser Arg Arg Pro Gly Ala Arg Ser Leu Leu Asp Val Ala Cys Gly
35 40 45

Thr Gly Ala His Leu Glu Ala Phe Arg Gly Leu Phe Ala His Thr Glu
50 55 60

Gly Leu Glu Leu Ser Asp Glu Met Arg Ala Leu Ala Glu Arg Arg Leu
65 70 75 80

Pro Gly Val Pro Val Arg Pro Gly Asp Met Arg Asp Phe Ala Leu Ser
85 90 95

Gly Arg Phe Asp Ala Val Val Cys Leu Phe Cys Ser Ile Gly Tyr Leu
100 105 110

Glu Thr Val Ala Asp Met Arg Ala Ala Val Arg Thr Met Ala Ala His
115 120 125

Leu Val Pro Gly Gly Val Leu Val Val Glu Pro Trp Trp Phe Pro Glu
130 135 140

Arg Phe Leu Glu Gly Tyr Val Ala Gly Asp Leu Ala Arg Gly Glu Gly
145 150 155 160

Arg Thr Val Ala Arg Val Ser His Ser Thr Arg Gln Gly Arg Arg Thr
165 170 175

Arg Met Glu Val Arg Phe Leu Val Gly Glu Ala Thr Gly Ile Arg Glu
180 185 190

Phe Thr Glu Ile Asp Leu Leu Thr Leu Phe Thr Arg Glu Glu Tyr Leu
195 200 205

Ala Ala Phe Glu Asp Ala Gly Cys Pro Ala Glu Phe Leu Asp Asp Gly
210 215 220

Leu Thr Gly Arg Gly Leu Phe Val Gly Val Arg Gly Ala Gly
225 230 235

<210> 5
<211> 324
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *snoa*M, function: polyketide cyclase"

<400> 5

Met Thr Ala Ala Trp Gly Ala Pro Leu Tyr Pro Pro Trp Ile Pro Ala
1 5 10 15

Arg Pro Gly Arg Arg Arg Cys Gly Ala Gly Arg Arg Val Arg Cys Pro
20 25 30

Pro Val Glu Pro Ala Ser Arg Pro Arg Gln Glu Gly Arg Val Ser Val
35 40 45

Val Pro Ala Leu Arg Gln Pro Ser Pro Ser Thr Asn Pro Glu Val Arg
50 55 60

Val Arg Leu Ile Asp Leu Ser Ser Pro Val Asp Ser Ser Gln Tyr Glu
65 70 75 80

Pro Asp Pro Val Val His Asp Val Leu Thr Pro Arg Gln Gly Ala Glu
85 90 95

His Met Cys Ala Glu Met Arg Glu His Phe Gly Val Glu Phe Ser Pro
100 105 110

Asp Glu Leu Pro Asp Gly Glu Phe Leu Ser Leu Asp Arg Ile Thr Leu
115 120 125

Thr Thr His Thr Gly Thr His Val Asp Ala Pro Ser His Tyr Gly Ser
130 135 140

Arg Ala Leu Tyr Gly Asp Gly Val Pro Arg His Ile Asp Gln Met Pro
145 150 155 160

Leu Glu Trp Phe Phe Gly Arg Gly Val Val Leu Asp Leu Thr Asp Ala
165 170 175

Pro Thr Gly Thr Val Ser Ala Ala Arg Leu Glu Lys Glu Leu Ala Arg
180 185 190

Thr Gly Cys Ala Leu Arg Pro Gly Asp Ile Val Leu Leu His Thr Gly
195 200 205

```
Ala Gln Arg His Ala Gly Thr Pro Arg Tyr Phe Thr Asp Phe Ala Gly
    210                 215                 220

Leu Asp Gly Pro Ala Val Arg Met Leu Leu Asp His Gly Val Arg Val
225                 230                 235                 240

Ile Gly Thr Asp Ala Phe Ser Leu Asp Ala Pro Phe Gly His Ile Ile
                245                 250                 255

Asp Arg Tyr Arg Ala Thr Gly Asp Arg Ser Val Leu Trp Pro Ala His
            260                 265                 270

Val Val Gly Arg Glu Arg Glu Tyr Cys Gln Ile Glu Arg Leu Ala Asn
        275                 280                 285

Leu Asp Arg Leu Pro Val Ser Phe Gly Phe Arg Val Cys Cys Phe Pro
    290                 295                 300

Val Lys Val Ala Gly Ala Gly Ala Gly Trp Thr Arg Ala Val Ala Leu
305                 310                 315                 320

Val Asp Glu Asp
```

<210> 6
<211> 408
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *snog*N, function: unknown"

<400> 6

```
Met Val Met Lys Leu Thr Asp Ser Glu Leu Gly Arg Ala Leu Leu Ser
1               5                   10                  15

Leu Arg Gly Tyr Gln Trp Leu Arg Gly Ile His His Asp Pro Tyr Ala
            20                  25                  30

Leu Leu Leu Arg Ala Glu Ser Asp Asp Pro Ala Gln Leu Gly Arg Leu
        35                  40                  45

Leu Arg Glu Arg Gly Arg Leu His Arg Ser Asp Thr Gly Thr Trp Val
    50                  55                  60

Thr Ala Asp His Ala Thr Ala Ser Arg Leu Leu Ala Asp Pro Arg Phe
65                  70                  75                  80

Val Leu Arg Arg Pro Pro Ala Gly Pro Ala Thr Gly Thr Gly Asp Val
                85                  90                  95

Met Pro Trp Glu Glu Ala Thr Leu Ser Asp Leu Leu Pro Leu Asp Glu
            100                 105                 110

Ala Arg Leu Thr Thr Asp Arg Ala Arg Cys Arg Arg Leu Gly Ala Thr
        115                 120                 125

Ala Ala Arg Ile Ala Ala Asp Gly Pro Val Ala Thr Arg Leu Ala Asp
    130                 135                 140

Leu Ala Gly Ala Arg Ala Glu Gln Val Arg Ser Thr Gly His Phe Asp
145                 150                 155                 160

Leu Arg Ala Asp Tyr Ala Leu Pro Tyr Ala Val Glu Pro Ala Cys Ala
                165                 170                 175
```

Leu Leu Gly Leu Pro Ala Gly Gln Cys Ser Leu Phe Gly Ala Phe Ser
180 185 190

Pro Ala Val Leu Leu Asp Ala Thr Val Val Pro Pro Arg Leu Pro Glu
195 200 205

Ala Arg Ala Leu Ile Ala Ser Thr Ala Glu Leu Thr Ala Leu Trp Pro
210 215 220

Arg Leu Ala Pro Ser Leu Ser Lys Thr Val Pro Glu Asp Glu Ala Pro
225 230 235 240

Asp Leu Phe Leu Leu Thr Ala Val Leu Leu Val Pro Ala Val Val His
245 250 255

Leu Val Cys Glu Ala Val Ala Ala Leu Ser His Asp Pro Gly Gln Ala
260 265 270

Gly Leu Leu Arg Asp Asp Pro Val Leu Ala Ala Pro Ala Val Glu Glu
275 280 285

Thr Leu Arg His Ala Pro Pro Ala Arg Leu Phe Thr Leu His Ala Thr
290 295 300

Gly Pro Glu Arg Val Ala Asp Val Asp Leu Pro Ala Gly Ala Glu Val
305 310 315 320

Ala Val Val Val Ala Ala Ala His Arg Asp Pro Ser Trp Cys Pro Asp
325 330 335

Pro Asp Arg Phe Asp Leu Thr Arg Asn Glu Arg His Leu Ala Leu Pro
340 345 350

Pro Asp Leu Pro Leu Gly Ala Leu Ala Pro Leu Leu Arg Val Cys Ala
355 360 365

Thr Ala Ala Val Ala Ala Leu Ala Ala Gly Leu Leu Pro Leu Arg Ala
370 375 380

Val Gly Pro Pro Val Arg Arg Leu Arg Ala Pro Val Thr Arg Ser Val
385 390 395 400

Leu Arg Phe Pro Val Ala Pro Cys
405

<210> 7
<211> 422
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *sno*aG, function: hydroxylase"

<400> 7

Met Asp Asn Arg Glu Thr Val Arg Pro Val Ser Val Cys Arg Val Cys
1 5 10 15

Gly Gly Asn Asp Trp Gln Asp Val Val Asp Phe Gly Asp Val Pro Leu
20 25 30

Ala Asn Gly Phe Leu Ser Pro Ala Asp Ser Tyr Glu Asn Glu Arg Arg
35 40 45

Tyr Pro Leu Gly Val Leu Ser Cys Arg Ala Cys Arg Leu Met Ser Leu
50 55 60

Thr His Val Val Asp Pro Glu Val Leu Tyr Arg Asp Tyr Ala Tyr Thr
65 70 75 80

Thr Pro Asp Ser Glu Met Ile Thr Gln His Met Arg His Ile Thr Ala
85 90 95

Leu Cys Arg Thr Arg Phe Glu Leu Pro Pro Asp Ser Leu Val Val Glu
100 105 110

Leu Gly Ser Asn Thr Gly Arg Gln Leu Met Ala Phe Arg Glu Ala Gly
115 120 125

Met Arg Thr Leu Gly Val Asp Pro Ala Arg Asn Leu Thr Asp Val Ala
130 135 140

Arg Arg Asn Gly Ile Glu Thr Phe Pro Asp Phe Phe Ser His Asp Val
145 150 155 160

Ala Arg Thr Ile Arg Arg Asp His Gly Gln Ala Arg Leu Val Leu Gly
165 170 175

Arg His Val Phe Ala His Ile Asp Asp Val Ser Asp Ile Ala Ala Gly
180 185 190

Val Arg Glu Leu Leu Ser Pro Asp Gly Val Phe Ala Ile Glu Val Pro
195 200 205

Tyr Val Leu Asp Leu Leu Glu Lys Val Ala Phe Asp Thr Ile Tyr His
210 215 220

Glu His Leu Ser Tyr Phe Thr Met Arg Ser Phe Val Thr Leu Phe Ala
225 230 235 240

Arg His Gly Leu Arg Val Leu Asp Val Glu Arg Phe Gly Val His Gly
245 250 255

Gly Ser Val Leu Val Phe Val Gly His Glu Asp Gly Pro Trp Pro Glu
260 265 270

Arg Pro Ser Val Pro Glu Leu Leu Arg Val Glu Arg Gln Arg Gly Leu
275 280 285

Tyr Asp Asp Ala Thr Tyr Arg Thr Phe Ala Gln Arg Ile Glu Arg Val
290 295 300

Arg Thr Glu Leu Pro Glu Leu Leu Arg Ser Leu Val Ala Gln Gly Lys
305 310 315 320

Arg Ile Val Gly Tyr Gly Ala Pro Ala Lys Gly Asn Thr Ile Leu Thr
325 330 335

Val Cys Gly Leu Gly Leu Lys Glu Leu Glu Tyr Cys Thr Asp Thr Thr
340 345 350

Glu Leu Lys Gln Gly Arg Val Leu Pro Gly Thr His Ile Pro Val His
355 360 365

Ala Pro Glu His Ala Lys Glu His Ile Pro Asp Tyr Tyr Leu Leu Leu
370 375 380

Ala Trp Asn Tyr Ala Thr Glu Ile Leu Asp Lys Glu Thr Ala Phe Arg
385 390 395 400

Asp Asn Gly Gly Arg Phe Ile Val Pro Ile Pro Arg Pro Ser Ile Leu
405 410 415

Thr Ser Pro Ser Gly Ser
420

<210> 8
<211> 291
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *snog*C, function: dTDP-4-dehydrorhamnose reductase"

<400> 8

Met Leu Ala Arg His Leu Thr Ala Ala Leu Ala Glu Thr Gly Arg Ser
1 5 10 15

Arg Pro Ala Ala Glu Ala Val Val Leu Gly Arg Arg Ala Leu Asp Ile
20 25 30

Thr Asp Gly Arg Ala Val Asp Ala Ala Phe Ala Ala His Arg Pro Arg
35 40 45

Val Val Val Asn Cys Ala Ala Phe Thr Asp Val Asp Gly Ala Glu Ser
50 55 60

Arg Trp Ala Glu Ala Met Arg Val Asn Gly Gly Gly Pro Arg Leu Leu
65 70 75 80

Ala Arg Arg Cys Ala Arg His Gly Val Arg Leu Ile His Val Ser Thr
85 90 95

Asp Tyr Val Phe Pro Gly Asp Thr Arg Ser Pro Tyr Gly Glu Ser Asp
100 105 110

Ala Pro Gly Pro Arg Thr Val Tyr Gly Arg Ser Lys Leu Ala Gly Glu
115 120 125

Arg Ala Val Leu Ser Leu Leu Pro Asp Thr Gly Thr Val Val Arg Thr
130 135 140

Ala Trp Leu Tyr Gly Gly Gln Gly Arg Ser Phe Val Arg Thr Met Leu
145 150 155 160

Glu Arg Ala Pro Asp Asp Gly His Val Asp Val Val Asn Asp Gln Trp
165 170 175

Gly Gln Pro Thr Trp Ala Gly Asp Val Ala Arg Leu Leu Val Thr Leu
180 185 190

Ala Arg Thr Pro Pro Asp Arg Ala Arg Gly Ile Phe His Ala Thr Asn
195 200 205

Ala Gly Ala Ala Thr Trp Tyr Glu Leu Ala Arg Glu Val Phe Arg Leu
210 215 220

Ala Gly Ala Asp Pro Glu Arg Val Arg Pro Val Ala Thr Ala Asp Arg
225 230 235 240

Pro Gly Pro Ala Pro Arg Pro Ala Cys Thr Val Leu Gly His Asp Arg
245 250 255

Trp Arg Leu Val Gly Val Ala Pro Pro Arg Asp Trp Arg Ala Ala Leu
260 265 270

Arg Glu Ala Met Arg Gln Leu Leu Pro Gly Gly Arg Leu Arg Asn Leu
275 280 285

Thr Gly Thr
290

<210> 9
<211> 350
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *sno*gK, function: dTDP-glucose-4,6-dehydratase"

<400> 9

Met Ala Ser His Thr Ser Ala Thr Thr Asp Val Asn Ile Leu Val Thr
1 5 10 15

Gly Ala Val Gly Phe Ile Gly Ser Ala Tyr Val Arg Met Leu Leu Glu
20 25 30

Asn Arg Ala Pro Gly Ala Gly Ala Pro Ala Val Arg Val Thr Val Leu
35 40 45

Asp Lys Leu Thr Tyr Ala Gly Asn Leu Thr Asn Leu Asp Ala Val Arg
50 55 60

Gly Asp Arg Leu Arg Phe Val Arg Gly Asp Ile Leu Asp Ala Glu Leu
65 70 75 80

Val Asp Glu Leu Met Ala His Ser Asp Gln Val Val His Phe Ala Ala
85 90 95

Glu Ser His Val Asp Arg Ser Ile Arg Ala Ala Asp Asp Phe Val Leu
100 105 110

Thr Asn Val Val Gly Thr Gln Arg Leu Leu Asp Ala Ala Leu Arg His
115 120 125

Gly Val Glu Pro Phe Val Leu Val Ser Thr Asp Glu Val Tyr Gly Ser
130 135 140

Ile Ala Ser Gly Ser Trp Pro Glu Glu His Pro Leu Ser Pro Asn Ser
145 150 155 160

Pro Tyr Ala Ala Ser Lys Ala Ser Ala Asp Leu Met Ala Phe Ala Cys
165 170 175

His Arg Thr His Gly Leu Asp Val Arg Val Thr Arg Cys Ser Asn Asn
180 185 190

Tyr Gly Pro Arg Gln His Pro Glu Lys Leu Ile Pro Arg Phe Val Thr
195 200 205

Asn Leu Leu Asp Gly Leu Pro Val Pro Leu Tyr Gly Asp Gly Arg Asn
210 215 220

Val Arg Glu Trp Leu His Val Glu Asp His Cys Arg Gly Val Asp Leu
225 230 235 240

Val Arg Thr Ala Gly Arg Pro Gly Gly Val Tyr His Ile Gly Gly Gly
245 250 255

Arg Glu Leu Ser Asn Arg Glu Leu Val Gly Met Leu Leu Glu Leu Cys
260 265 270

Gly Ala Asp Trp Ser Ser Val Arg His Val Pro Asp Arg Lys Gly His
275 280 285

Asp Leu Arg Tyr Ser Leu Asp Trp Gly Arg Ala Arg Glu Glu Leu Gly
290 295 300

Tyr Arg Pro Ala Arg Glu Phe Ser Ser Gly Leu Arg Ser Thr Val Gln
305 310 315 320

Trp Tyr Arg Glu Asn Arg Ser Trp Trp Glu Pro Leu Lys Arg Gly Val
325 330 335

Thr Ala Pro Gly Gly Thr Ser Thr Val Val Pro Gly Val Arg
340 345 350

<210> 10
<211> 134
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *sno*aL, function: NAME cyclase"

<400> 10

Met Val Ser Ala Phe Asn Thr Gly Arg Thr Asp Asp Val Asp Glu Tyr
1 5 10 15

Ile His Pro Asp Tyr Leu Asn Pro Ala Thr Leu Glu His Gly Ile His
20 25 30

Thr Gly Pro Lys Ala Phe Ala Gln Leu Val Gly Trp Val Arg Ala Thr
35 40 45

Phe Ser Glu Glu Ala Arg Leu Glu Glu Val Arg Ile Glu Glu Arg Gly
50 55 60

Pro Trp Val Lys Ala Tyr Leu Val Leu Tyr Gly Arg His Val Gly Arg
65 70 75 80

Leu Val Gly Met Pro Pro Thr Asp Arg Arg Phe Ser Gly Glu Gln Val
85 90 95

His Leu Met Arg Ile Val Asp Gly Lys Ile Arg Asp His Arg Asp Trp
100 105 110

Pro Asp Phe Gln Gly Thr Leu Arg Gln Leu Gly Asp Pro Trp Pro Asp
115 120 125

Asp Glu Gly Trp Arg Pro
130

<210> 11
<211> 235
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *sno*K, function: unknown"

<400> 11

Met Pro Asp Pro Gly Gly Pro Thr Thr Ala Glu Asn Leu Ser Lys Glu
1 5 10 15

Ala Val Arg Phe Tyr Arg Glu Gln Gly Tyr Val His Ile Pro Arg Val
20 25 30

Leu Ser Glu Thr Glu Val Thr Ala Phe Arg Ala Ala Cys Glu Glu Val
35 40 45

Leu Glu Lys Glu Gly Arg Glu Ile Ser Gly Ile Ala Leu Arg Leu Ala
50 55 60

Gly Ala Pro Leu Arg Val Tyr Ser Ser Asp Ile Leu Val Lys Glu Pro
65 70 75 80

Lys Arg Thr Leu Pro Thr Leu Val His Asp Asp Glu Thr Gly Leu Pro
85 90 95

Leu Asn Glu Leu Ser Ala Thr Leu Thr Ala Trp Ile Ala Leu Thr Asp
100 105 110

Val Pro Val Glu Arg Gly Cys Met Ser Tyr Val Pro Gly Ser His Leu
115 120 125

Arg Ala Arg Glu Asp Arg Gln Glu His Met Thr Ser Phe Ala Glu Phe
130 135 140

Arg Asp Leu Ala Asp Val Trp Pro Asp Tyr Pro Trp Gln Pro Arg Val
145 150 155 160

Ala Val Pro Val Arg Ala Gly Asp Val Val Phe His His Cys Arg Thr
165 170 175

Val His Met Ala Glu Ala Asn Thr Ser Asp Ser Val Arg Met Ala His
180 185 190

Gly Val Val Tyr Met Asp Ala Asp Ala Thr Tyr Arg Pro Gly Val Gln
195 200 205

Asp Gly His Leu Ser Arg Leu Ser Pro Gly Asp Pro Leu Glu Gly Glu
210 215 220

Leu Phe Pro Leu Val Thr Ala Gly Thr Arg Gln
225 230 235

<210> 12
<211> 390
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *snog*D, function: glycosyl transferase"

<400> 12

Met Arg Val Pro Gly Ser Cys Arg Thr Gly Gly Ile Met Arg Ala Leu
1 5 10 15

Phe Ile Thr Ser Pro Gly Leu Ser His Ile Leu Pro Thr Val Pro Leu
20 25 30

Ala Gln Ala Leu Arg Ala Leu Gly His Glu Val Arg Tyr Ala Thr Gly
35 40 45

Gly Asp Ile Arg Ala Val Ala Glu Ala Gly Leu Cys Ala Val Asp Val
50 55 60

Ser Pro Gly Val Asn Tyr Ala Lys Leu Phe Val Pro Asp Asp Thr Asp
65 70 75 80

Val Thr Asp Pro Met His Ser Glu Gly Leu Gly Glu Gly Phe Phe Ala
85 90 95

Glu Met Phe Ala Arg Val Ser Ala Val Ala Val Asp Gly Ala Leu Arg
100 105 110

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Thr Ala Arg Ser Trp Arg Pro Asp Leu Val Val His Thr Pro Thr Gln
        115                 120                 125

Gly Ala Gly Pro Leu Thr Ala Ala Ala Leu Gln Leu Pro Cys Val Glu
    130                 135                 140

Leu Pro Leu Gly Pro Ala Asp Ser Glu Pro Gly Leu Gly Ala Leu Ile
145                 150                 155                 160

Arg Arg Ala Met Ser Lys Asp Tyr Glu Arg His Gly Val Thr Gly Glu
                165                 170                 175

Pro Thr Gly Ser Val Arg Leu Thr Thr Thr Pro Pro Ser Val Glu Ala
            180                 185                 190

Leu Leu Pro Glu Asp Arg Arg Ser Pro Gly Ala Trp Pro Met Arg Tyr
        195                 200                 205

Val Pro Tyr Asn Gly Gly Ala Val Leu Pro Asp Trp Leu Pro Pro Ala
    210                 215                 220

Ala Gly Arg Arg Arg Ile Ala Val Thr Leu Gly Ser Ile Asp Ala Leu
225                 230                 235                 240

Ser Gly Gly Ile Ala Lys Leu Ala Pro Leu Phe Ser Glu Val Ala Asp
                245                 250                 255

Val Asp Ala Glu Phe Val Leu Thr Leu Gly Gly Gly Asp Leu Ala Leu
            260                 265                 270

Leu Gly Glu Leu Pro Ala Asn Val Pro Val Val Glu Trp Ile Pro Leu
        275                 280                 285

Gly Ala Leu Leu Glu Thr Cys Asp Ala Ile Ile His His Gly Gly Ser
    290                 295                 300

Gly Thr Leu Leu Thr Ala Leu Ala Ala Gly Val Pro Gln Cys Val Ile
305                 310                 315                 320

Pro His Gly Ser Tyr Gln Asp Thr Asn Arg Asp Val Leu Thr Gly Leu
                325                 330                 335

Gly Ile Gly Phe Asp Ala Glu Ala Gly Ser Leu Gly Ala Glu Gln Cys
            340                 345                 350

Arg Arg Leu Leu Asp Asp Ala Gly Leu Arg Glu Ala Ala Leu Arg Val
        355                 360                 365

Arg Gln Glu Met Ser Glu Met Pro Pro Pro Ala Glu Thr Ala Ala Lys
    370                 375                 380

Leu Val Ala Leu Ala Gly
385                 390
```

<210> 13
<211> 275
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *snoW*, function: unknown"

<400> 13

```
Met Thr Val Leu Val Thr Gly Ala Thr Gly Asn Val Gly Arg His Val
1               5                   10                  15
```

Val Thr Gly Leu Leu Ala Ala Gly Arg Arg Val Arg Ala Leu Thr Arg
20 25 30

Thr Pro Asp Arg Ser Gly Leu Pro Gly Gly Ala Glu Ile Thr Gly Gly
35 40 45

Asp Leu Thr Arg Pro Glu Thr Tyr Glu Arg Met Leu Asp Gly Val Glu
50 55 60

Ala Val Tyr Leu Phe Pro Val Pro Glu Thr Ala Ala Ala Phe Ala Gly
65 70 75 80

Ala Ala Arg Arg Ala Gly Val Arg Arg Ile Val Val Leu Ser Ser Asp
85 90 95

Ser Val Thr Asp Gly Thr Asp Thr Gly Gly His Arg Arg Val Glu Leu
100 105 110

Ala Val Glu Asp Thr Gly Leu Glu Trp Thr His Val Arg Pro Gly Glu
115 120 125

Phe Ala Leu Asn Lys Val Thr Leu Trp Ala Pro Ser Ile Arg Ala Glu
130 135 140

Gly Val Val Arg Ser Ala Tyr Pro Asp Ala Arg Val Ala Pro Val His
145 150 155 160

Glu Ala Asp Val Ala Ala Val Ala Val Thr Ala Leu Leu Lys Glu Gly
165 170 175

His Ala Gly Arg Ala Tyr Ser Val Thr Gly Pro Gln Ala Leu Thr Gln
180 185 190

Arg Glu Gln Val Arg Ala Val Gly Glu Gly Leu Gly Arg Ser Leu Ala
195 200 205

Phe Val Glu Val Thr Pro Gly Gln Ala Arg Ala Asp Leu Thr Ala Gln
210 215 220

Gly Leu Pro Ala Pro Ile Ala Asp Tyr Val Leu Ala Phe Gln Ala Gly
225 230 235 240

Trp Thr Glu Arg Pro Ala Pro Ala Arg Pro Thr Val Arg Glu Val Thr
245 250 255

Gly Arg Pro Ala Arg Thr Leu Ala Gln Trp Ala Ala Asp His Arg Ala
260 265 270

Asp Phe Arg
275

<210> 14
<211> 424
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *snog*E, function: glycosyl transferase"

<400> 14

Val Arg Val Leu Leu Thr Ser Phe Ala Met Asp Ala His Phe Cys Thr
1 5 10 15

Ala Val Pro Leu Ala Trp Ala Leu Arg Ser Ala Gly His Glu Val Arg
20 25 30

Val Ala Gly Gln Pro Ala Leu Thr Ser Thr Ile Thr Gly Ala Gly Leu
35 40 45

Thr Ala Val Pro Val Gly Arg Asp His Thr His Gly Ser Leu Leu Gly
50 55 60

Arg Val Gly Ser Asp Ile Leu Ala Leu His Asp Glu Ala Asp Tyr Leu
65 70 75 80

Glu Ala Arg His Asp Ala Leu Gly Phe Glu Phe Leu Lys Gly His Asn
85 90 95

Thr Val Met Ser Ala Leu Phe Tyr Ser Gln Ile Asn Asn Asp Ser Met
100 105 110

Val Asp Asp Leu Val Asp Phe Ala Arg His Trp Arg Pro Asp Leu Val
115 120 125

Val Trp Glu Pro Phe Thr Phe Ala Gly Ala Val Ala Ala Arg Ala Ser
130 135 140

Gly Ala Ala His Ala Arg Leu Leu Ser Phe Pro Asp Leu Phe Leu Ser
145 150 155 160

Thr Arg Arg Leu Phe Leu Glu Arg Met Ala Arg Gln Glu Pro Glu His
165 170 175

His Asp Asp Thr Leu Ala Glu Trp Leu Asp Trp Thr Leu Gly Arg His
180 185 190

Gly His Ser Phe Asp Glu Glu Ile Val Thr Gly Gln Trp Ser Ile Asp
195 200 205

Gln Thr Pro Ala Pro Val Arg Leu Asp Ala Gly Gly Pro Thr Val Pro
210 215 220

Met Arg Tyr Val Pro Tyr Ser Gly Leu Val Pro Thr Val Val Pro Asp
225 230 235 240

Trp Leu Arg Arg Pro Pro Glu Arg Pro Arg Val Leu Val Thr Leu Gly
245 250 255

Ile Thr Ser Arg Arg Val Lys Ser Phe Leu Ala Val Ser Val Asp Asp
260 265 270

Leu Phe Glu Ala Val Ala Gly Leu Gly Val Glu Val Val Ala Thr Leu
275 280 285

Asp Ala Asp Gln Arg Glu Leu Leu Gly Arg Val Pro Asp His Phe Arg
290 295 300

Ile Val Glu His Val Pro Leu Asp Ala Val Leu Pro Thr Cys Ser Ala
305 310 315 320

Ile Val His His Gly Gly Ala Gly Thr Trp Ser Thr Ala Ala Val Tyr
325 330 335

Gly Val Pro Gln Val Ser Leu Gly Ser Met Trp Asp His Phe Tyr Arg
340 345 350

Ala Arg Arg Leu Glu Glu Leu Gly Ala Gly Leu Arg Leu Pro Ser Gly
355 360 365

Glu Leu Thr Ala Glu Gly Leu Arg Thr Arg Leu Glu Arg Val Leu Gly
370 375 380

Glu Pro Ser Phe Gly Thr Ala Ala Gln Ala Leu Ser Asp Thr Ile Ala
385 390 395 400

Ala Glu Pro Ser Pro Ser Glu Val Val Pro Val Leu Glu Glu Leu Thr
405 410 415

Gly Arg His Arg Pro Gly Thr Arg
420

<210> 15
<211> 139
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *sno*L, function: unknown"

<400> 15

Met Ser Thr Thr Ala Asn Lys Glu Arg Cys Leu Glu Met Val Ala Ala
1 5 10 15

Trp Asn Arg Trp Asp Val Ser Gly Val Val Ala His Trp Ala Pro Asp
20 25 30

Val Val His Tyr Asp Asp Glu Asp Lys Pro Val Ser Ala Glu Glu Val
35 40 45

Val Arg Arg Met Asn Ser Ala Val Glu Ala Phe Pro Asp Leu Arg Leu
50 55 60

Asp Val Arg Ser Ile Val Gly Glu Gly Asp Arg Val Met Leu Arg Ile
65 70 75 80

Thr Cys Ser Ala Thr His Gln Gly Val Phe Met Gly Ile Ala Pro Thr
85 90 95

Gly Arg Lys Val Arg Trp Thr Tyr Leu Glu Glu Leu Arg Phe Ser Glu
100 105 110

Ala Gly Lys Val Val Glu His Trp Asp Val Phe Asn Phe Ser Pro Leu
115 120 125

Phe Arg Asp Leu Gly Val Val Pro Asp Gly Leu
130 135

<210> 16
<211> 155
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *sno*O, function: homologous to *mtm*X of mithramycin cluster"

<400> 16

Met Ser Val Arg Thr Asp Gln Thr Ala Ala Pro Glu Asp Arg Ala Ala
1 5 10 15

Ala Thr Asp Pro Gly Phe Gly His Leu Tyr Ala Gln Val Gln Gln Phe
20 25 30

Tyr Ala Arg Gln Met Gln Leu Leu Asp Ser Gly Ala Ala Glu Glu Trp
35 40 45

Ala Ala Thr Phe Thr Glu Asp Gly Thr Phe Ala Arg Pro Ser Ser Pro
50 55 60

Glu Pro Ala Arg Gly His Ala Glu Leu Ala Ala Gly Ala Arg Ala Ala
65 70 75 80

Ala Glu Arg Leu Ala Ala Glu Gly Leu Ser His Arg His Val Ile Gly
85 90 95

Met Thr Ala Val Arg Arg Glu Pro Asp Gly Ser Val Phe Val Arg Ser
100 105 110

Tyr Ala Gln Val Phe Ala Thr Arg Arg Gly Glu Ala Pro Arg Leu His
115 120 125

Leu Ile Cys Val Cys Glu Asp Val Leu Val Arg Glu Gly Pro Gly Leu
130 135 140

Lys Val Arg Glu Arg Val Val Thr His Asp Ala
145 150 155

<210> 17
<211> 281
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *sno*aF, function: C-7 ketoreductase"

<400> 17

Val Arg Ala Met Thr Asp Ser Thr Gly Pro Arg Pro Val Pro Ala Met
1 5 10 15

Ser Pro Ala Pro Ser Pro Thr Pro Ser Pro Gly Pro Ala Pro Gly Ser
20 25 30

Glu Pro Ala Pro Leu Ala Val Ile Val Thr Gly Gly Gly Ser Gly Ile
35 40 45

Gly Arg Ala Thr Ala Arg Ala Phe Ala Ala Gln Gly Ala Lys Val Leu
50 55 60

Val Val Gly Arg Thr Glu Asp Ala Leu Ala Gln Thr Ala Glu Gly Cys
65 70 75 80

Ala Asp Met Arg Val Leu Val Ala Asp Val Ala Ser Pro Asp Gly Pro
85 90 95

Gln Ala Val Val Asn Ala Ala Leu Arg Glu Phe Gly Arg Ile Asp Val
100 105 110

Leu Val Asn Asn Ala Ala Val Ala Gly Met Glu Thr Leu Gln Thr Val
115 120 125

Asp Arg Asp Ala Val Ala Arg Gln Phe Gly Thr Asn Leu Thr Ala Pro
130 135 140

Leu Phe Leu Val Gln Ser Ala Leu Gly Ala Leu Glu Lys Ser Arg Gly
145 150 155 160

Ile Val Val Asn Val Gly Thr Ala Ala Thr Leu Gly Leu Arg Ala Ala
165 170 175

Pro Thr Gly Ala Leu Tyr Gly Ala Ser Lys Val Ala Leu Asp Tyr Leu
180 185 190

```
Thr Arg Thr Trp Ala Val Glu Leu Ala Pro Arg Gly Ile Arg Val Val
        195                 200                 205

Gly Val Ala Pro Gly Val Ile Asp Thr Gly Ile Gly Val Arg Met Gly
    210                 215                 220

Met Thr Pro Glu Gly Tyr Arg Glu Phe Leu Thr Gly Met Gly Gly Arg
225                 230                 235                 240

Val Pro Val Gly Arg Val Gly Arg Pro Glu Asp Val Ala Trp Trp Ile
                245                 250                 255

Val Gln Leu Ala Arg Pro Glu Ala Gly Tyr Ala Thr Gly Met Val Val
            260                 265                 270

Pro Val Asp Gly Gly Leu Ser Leu Val
        275                 280
```

<210> 18
<211> 190
<212> PRT
<213> *Streptomyces nogalater* ATCC 27451

<220>
<223> "translate of *sno*N, function: unknown"

<400> 18

```
Val Gln Glu Thr Glu Pro Gly Val Pro Ala Asp Leu Pro Ala Glu Ser
1               5                   10                  15

Asp Pro Ala Ala Leu Glu Arg Leu Ala Ala Arg Tyr Arg Arg Asp Gly
            20                  25                  30

Tyr Val His Val Pro Gly Val Leu Asp Ala Gly Glu Val Ala Glu Tyr
        35                  40                  45

Leu Ala Glu Ala Arg Arg Leu Leu Ala His Glu Glu Ser Val Arg Trp
    50                  55                  60

Gly Ser Gly Ala Gly Thr Val Met Asp Tyr Val Ala Asp Ala Gln Leu
65                  70                  75                  80

Gly Ser Asp Thr Met Arg Arg Leu Ala Thr His Pro Arg Ile Ala Ala
                85                  90                  95

Leu Ala Glu Tyr Leu Ala Gly Ser Pro Leu Arg Leu Phe Lys Leu Glu
            100                 105                 110

Val Leu Leu Lys Glu Asn Lys Glu Lys Asp Ala Ser Val Pro Thr Ala
        115                 120                 125

Pro His His Asp Ala Phe Ala Phe Pro Phe Ser Thr Ala Gly Thr Ala
    130                 135                 140

Leu Thr Ala Trp Val Ala Leu Val Asp Val Pro Val Glu Arg Gly Cys
145                 150                 155                 160

Met Thr Phe Val Pro Gly Ser His Leu Leu Pro Asp Pro Asp Thr Gly
                165                 170                 175

Asp Glu Pro Trp Ala Gly Ala Phe Thr Arg Pro Gly Glu Ile
            180                 185                 190
```